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PHARMACOGNOSTICAL STUDIES ON 'JIVANTI' PART IV*— *DREGEA VOLUBILIS* (LINN. F.) BENTH.

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ABSTRACT

'Jivanti' an important Ayurvedic drug, has variously been ascribed to different botanical taxa, *Dregea volubilis* (Linn.f.) Benth. being one such species. A detailed pharmacognosy of vegetative parts of the above species has been dealt within the present paper. This includes organoleptic and microscopic characters, fluorescence analysis of the drug powder and its behaviour on treating with different chemical reagents, preliminary phytochemical studies of various extractives and their TLC patterns and ash values. Some of the salient diagnostic characters revealed by this study are : diarch primary stele in the root, origin of phellcgen in the second cortical layer of stem, presence of pericycle as 2 rows of irregularly arranged strands of partially lignified fibres mixed with a few, sclereids, commonly occurring uni- and biseriate rays in both the root and the stem, a stout obscurely channelled petiole with three leaf traces, development of red colour in the aqueous extract of powdered root on heating with phloroglucinol and conc. HCl.

INTRODUCTION

The present paper deals with the pharmacognosy of *Dregea volubilis* (Linn. f.) Benth. (Asclepiadaceae) which is one of the several taxa implicated in Ayurvedic drug 'Jivanti' under the Sanskrit name 'Swarnjivanti'. 'Swarnjiva' and 'Hemakshiri' (Kirtikar and Basu, 1933 ; Datta and Mukherji, 1950 ; Chopra *et al.*, 1956 ; Chunekar, 1969 ; Gupta *et al.*, 1970 ; Gupta and Kapoor, 1971), although *Ephemerantha macraei* (Lindl.) Hunt & Summerh (syn. *Dendrobium macraei* Lindl., *Desmotrichum fimbriatum* auct. non Blume) family—Orchidaceae seems to be the botanical source of the 'bazar-jivanti' in the country as revealed by a comparison of morphological characters, both external and internal, of the marketed drug with those of the samples obtained from authenticated herbarium specimens. Detailed pharmacognostic work of the latter, and two other substitutes, *viz. Sarcostemma brevistigma* Wt. & Arn. and *Leptadenia reticulata* Wt. & Arn., the official 'jivanti' recommended by 'Pharmacopoeia committee of Indian medicine', is already published (Gupta *et al.*, 1970, Gupta and Wahi, 1978 ; Gupta and Kapoor, 1971).

The plant is a perennial large climbing shrub flowering in April to July. It is easily recognisable for its axillary or interpetiolar large umbelliform long peduncled cymes with light green flowers and large woody, longitudinally ribbed follicle being blunt at the apex as shown in figures 1G, H. It is distributed throughout the hotter parts of India and Ceylon and occurs in Himalayan region upto 1650 m from Bushar eastwards and extends to China and Java. The plant is reputed for its medicinal properties and denominated differently in different parts of the country (Kirtikar and Basu, 1933 ; Chopra *et al.*, 1956 ; Duthie, 1960 ; Bhandari, 1978).

In view of the importance of this drug some chemical work has been done (Chopra *et al.*, 1956 ; Sauer *et al.*, 1965, 1966 ; Allgeir, 1968). Datta and Mukerji (1950) have con-

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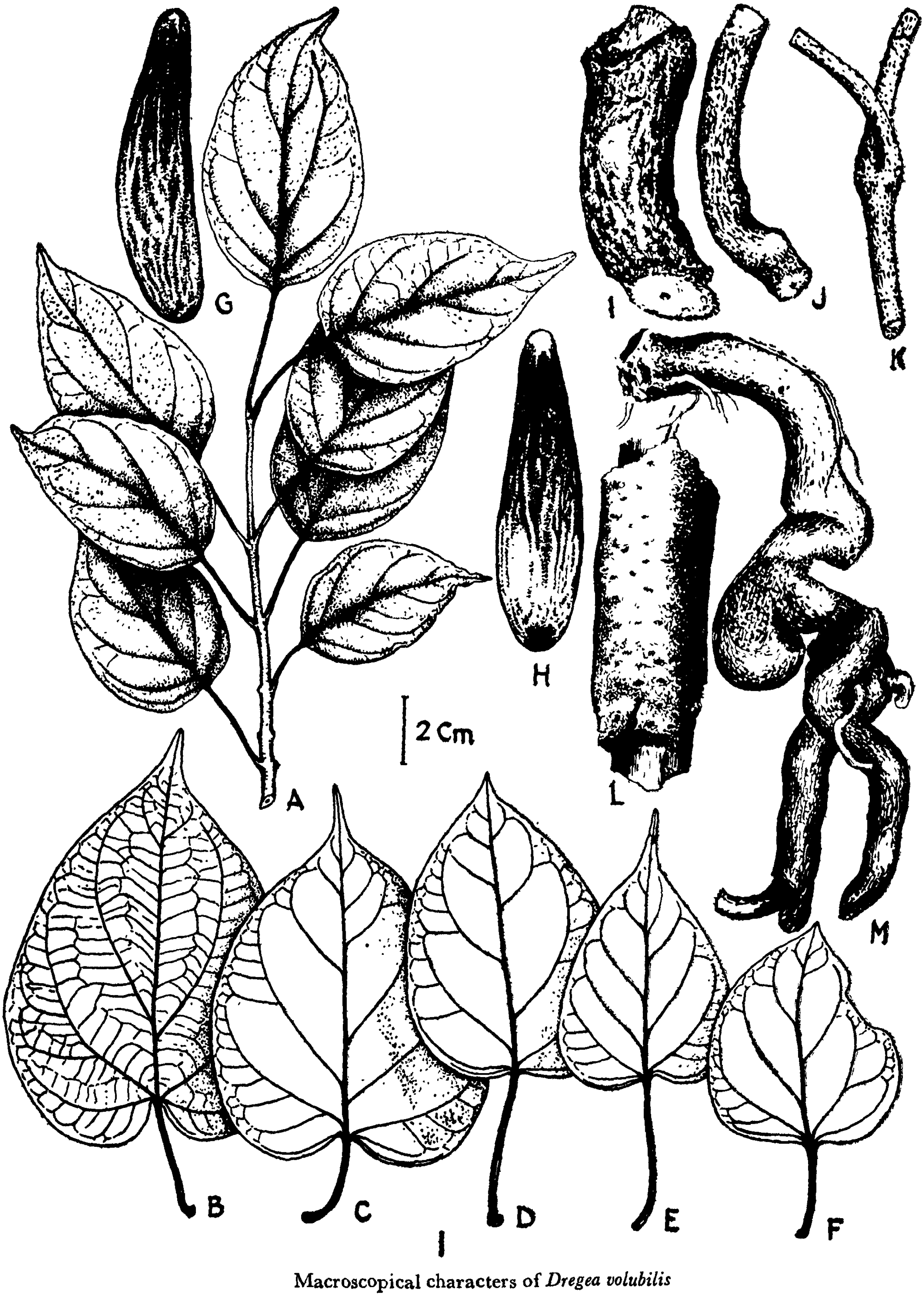
ducted a brief pharmacognostic study on the root of this species although all parts are useful medicinally, hence the present study.



Macroscopical characters of *Dregea volubilis*

Figs. 1 (A-M) : A. A twig. B-F. Leaves. G-H. Fruits. I-K. Pieces of stem. L-M. Pieces of root.

MATERIAL AND METHODS

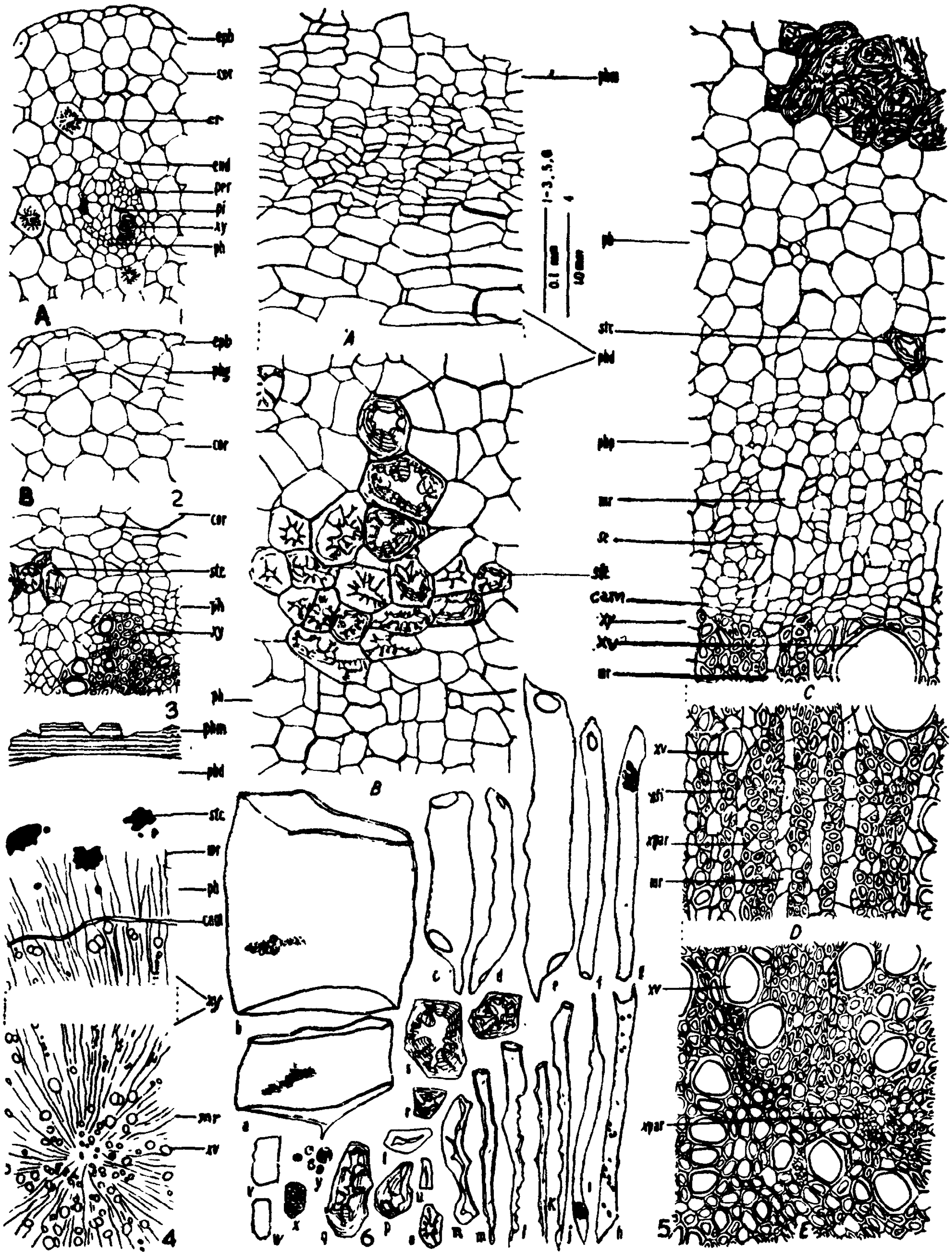
Root, stem and leaves at various stages of growth were collected from identified plants growing in Ayurvedic gardens of Banaras Hindu University in the month of September and October. Some dried and preserved plant materials collected from Andhra Pradesh in the month of December were also procured from Dr. K. K. Singh, Scientist, NBRI, Lucknow. The methods adopted for investigation were the same as in case of *Leptadenia reticulata* (Gupta and Kapoor, 1971).

OBSERVATIONS

Organoleptic and Microscopic Characters:

The present studies on *Dregea volubilis* have revealed that the root pieces (0.5 to 2.5 cm thick) are dark brown to buff-brown and rough due to fine longitudinal anastomosing wrinkles, small fissures, a few warty protuberances or scars of rootlets and a number of lenticels (Figs. 1L-M). Their taste is bitter and the fracture short and granular in the bark and fibrous in the wood. The primary stele is diarch (Fig. 2A). The secondary growth is normal and phellogen arises in the outermost cortical layer to produce periderm (Figs. 2B, 4, 5A). In a mature root (Figs. 3-8), the phloem has greater amount of parenchyma and some patches of sieve tubes and companion cells. Stone cells occur in phelloderm and phloem. In the latter these occur in concentric large and small groups (Figs. 3-5A-C). The phloem parenchyma in the outer region are bigger and easily distinguishable from those of tangentially elongated cells of broad rays. The narrow rays, more commonly are 1-2 cells wide and 8-15-25 or more cells high and sometimes, storied (Figs. 7A-B). The individual ray cells measure 17-34-47-69 × 21-37-52-78 μm. The xylem occupies almost 4/5th of root diameter and consists usual cells. The vessels occur diffusely in singles or groups of 2-3 arranged both radially and tangentially (Figs. 4, 5C-E). The tracheideal vessel elements being narrow and long, measuring 28-33-49 × 247-296-451 μm (Fig. 6f). The wide cylindrical ones measure 65-82-99 × 180-203-329 μm (Figs. 6c-e), while the short drum shaped vessel elements measure 108-164-214 × 213-263-329 μm (Figs. 6a, b). The bordered pits on their walls are alternate. The tracheids measure 16-30-40 × 213-350-460 μm with similar pits on their walls as those in vessel elements (Figs. 6g-i). The libriform xylem fibres measure 16-20-33 × 625-905-1152 μm (Figs. 6j-m). The xylem rays are heterogeneous narrow (uni- and biseriate) and 4-9-17-27 cells high with individual cells measuring 21-32-45 × 21-48-65 μm (Fig. 8).

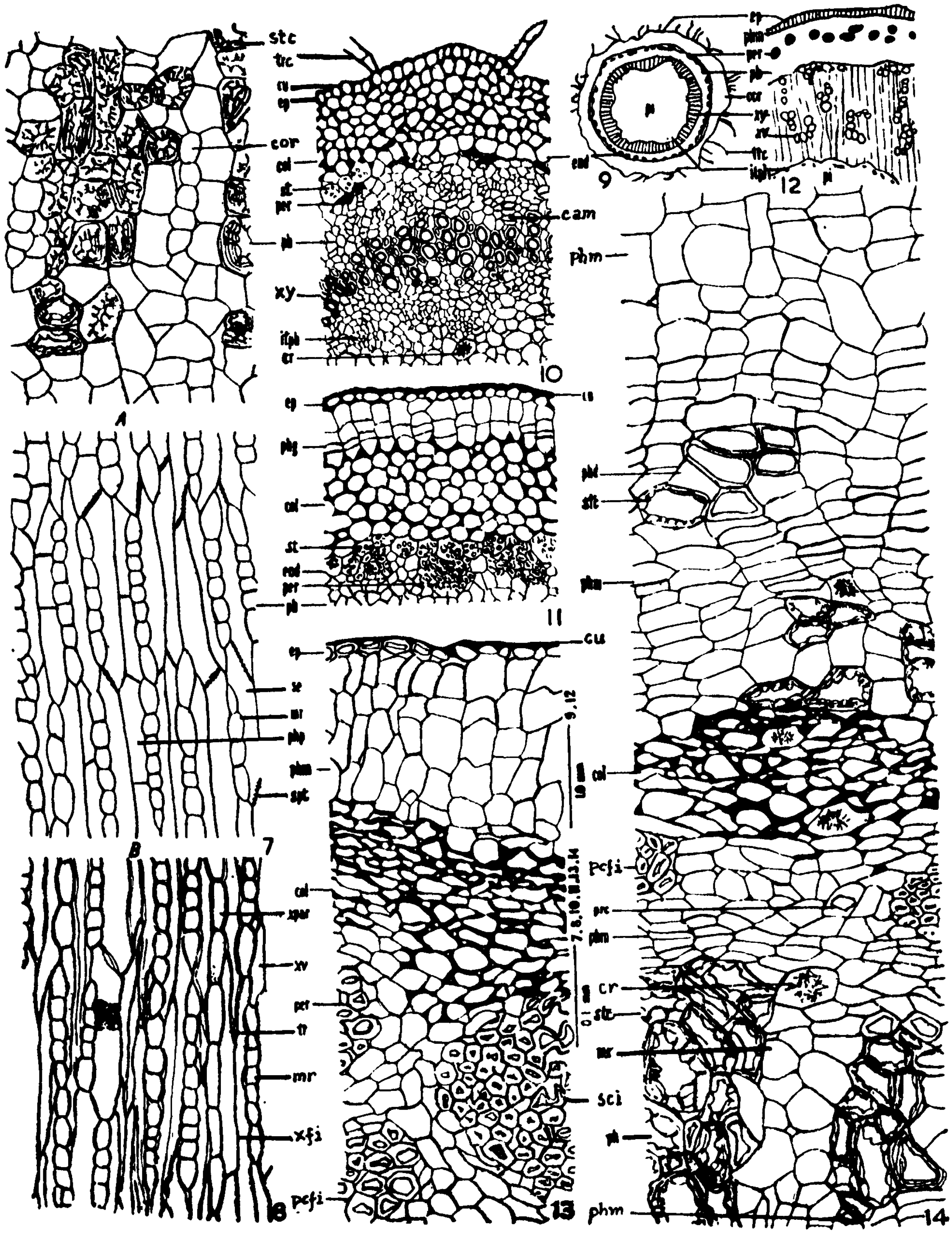
The pieces of the young branches of the stem are softly greyish or brownish hoary, while the older ones often lanticillate and pustular. Considerably mature stem pieces vary in diameter (1.5-3.5 cm) having ash coloured to buff-brown more rougher exterior than in the root (Figs. 1I-K). The cross-section of young stem shows single layered epidermis with uniseriate, multicellular trichomes (measure 13-15-17-21 × 110-150-277-304 μm) and the cortex composed of 4-6 layers of collenchyma followed by 1-2 layered parenchyma. Distinct starch sheath and patches of pericyclic cells surround the cylindrical amphiphloic siphonostele (Figs. 9-11). The secondary growth is normal and phellogen arises in outermost cortical layer (Fig. 11). The phellem cells produced at the early stage being radially elongated (measure 34-39-52 × 30-52-87 μm), where as those arising later are tangentially elongated (measure 22-45-65-92 × 13-52-89-174 μm) (Figs. 12-14). As the growth proceeds, the pericycle gets arranged in two irregular rings, each containing 19-34 strands of fibres (Figs. 12-14). The fibres are cellulosic, sometimes partially lignified and 10,000-15,000 μm



Microscopical characters of root of *Dregea volubilis*

Figs. 2-6 : 2. A. Part of t.s. of young root showing cellular details. B. Part of t.s. of young root showing phellogen formation in outermost cortical layer. 3. Part of t.s. of young root showing stone cell formation. 4. Part of t.s. of mature root (diagrammatic). 5. (A-E). Part of t.s. of fig. 4 showing cellular details. 6. Isolated elements : a-f. Vessel elements, g-i. Tracheids. j-m. Xylem fibres extremeties. n-v. Stone cells. w-y. Xylem parenchyma. z. Starch grains.

long. The stone cells develop in phelloderm, cortex and phloem region (Figs. 14-16) and the rhytidoma in the phelloderm, cortex and phloem (Fig. 14). The latter exfoliates gradually as rind of dead tissue. The stone cells, besides in small and large

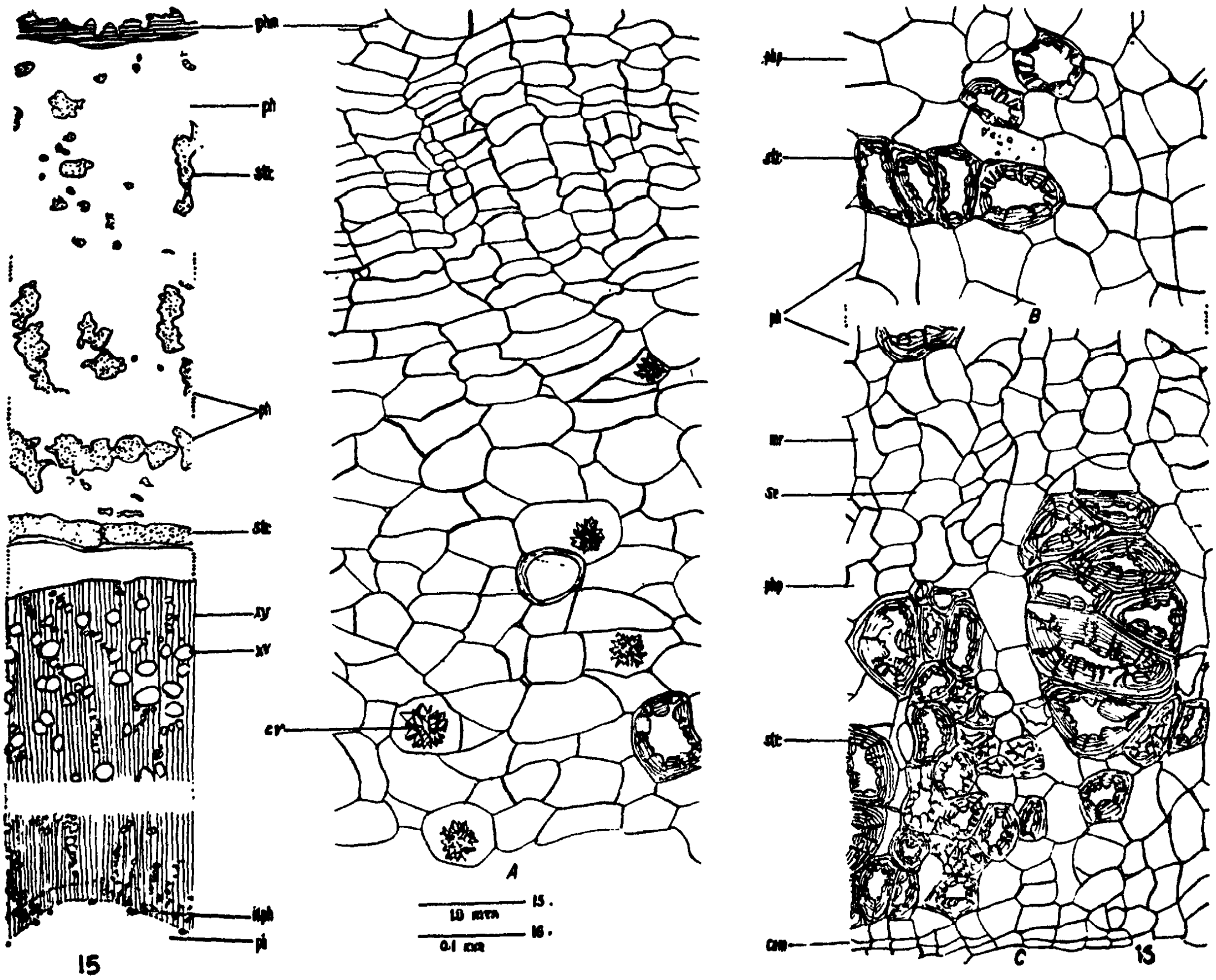


Microscopical characters of root and stem of *Dregea volubilis*

Figs. 7-14. 7. Tangential section of root through phloem region. A. Outer phloem. B. Inner phloem. 8. Tangential section of root through xylem. 9. T.S. of young stem (diagrammatic). 10. Part of t.s. of Fig. 9 showing cellular details. 11. Part of t.s. of stem showing phellogen formation. 12. Part of t.s. of early stages of mature stem (diagrammatic). 13. Part of t.s. of Fig. 12 showing cellular details of outer bark. 14. Part of t.s. of mature stem showing rhytidoma formation.

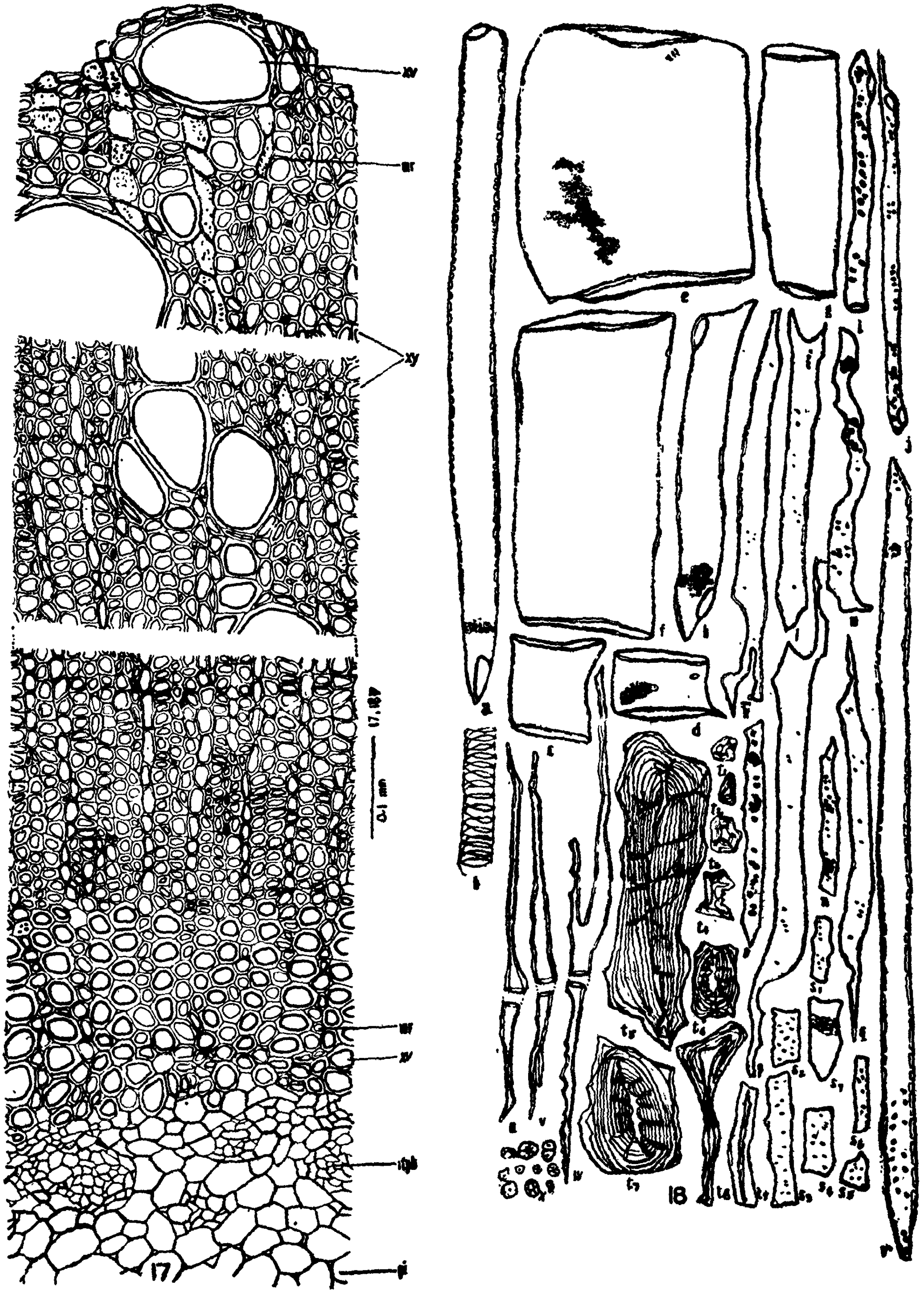
groups in outer phloem, occur in a continuous variably thickened band in the inner region and measure 34-86-174-348 × 69-104-156-250 μ m (Figs. 15, 16, 18t1-9). The phloem rays are heterogeneous 1-3 cells wide (more commonly uniseriate), 2-7-*18*-25 cells high and sometimes being storied as in root (Figs. 19-21). The individual ray cells measure 17-35-*48*-70 × 21-39-52-78 μ m. The xylem is diffused porous with vessels distributed singly or in short radial groups of 2-3 and in a few occasional oblique or dendritic arrangements (Figs. 15, 17). Of the various types of vessel elements (Figs. 18a-j) the narrow tracheideal ones measure 34-70 × 225-434 μm, the wide long cylindrical types 86-191 × 173-358 μm and the wide short drum-shaped ones 173-347 × 190-275μm. The bordered pits on their walls are alternate. The vessels in primary xylem towards the centre are, however, spiral and reticulately thickened (Figs. 13, 18b, 22). The tracheids measure 17-52 × 312-674 μ m and being usually bordered pitted except the primary types which have reticulate and annular thickenings (Figs. 18k-r, 22). The libriform fibres with a few oblique slit like bordered pits, measure 17-52 × 1145-1267 μ m (Figs. 18u-w). The xylem parenchyma are indistinct or as rare cells abuting the vessels (Fig. 17). These measure 21-143 × 73-143 μ m (Figure 18S1-7). The xylem rays are heterogeneous, narrow and 4-*14*-22-40 cells high (Figs. 22-24). The pith and the intraxylary phloem usually get collapsed (Fig. 17).

The leaves are broadly ovate or sub-orbicular and acuminate, 6.8-11 × 5-11.5 cm with base rounded truncated or cuneate and



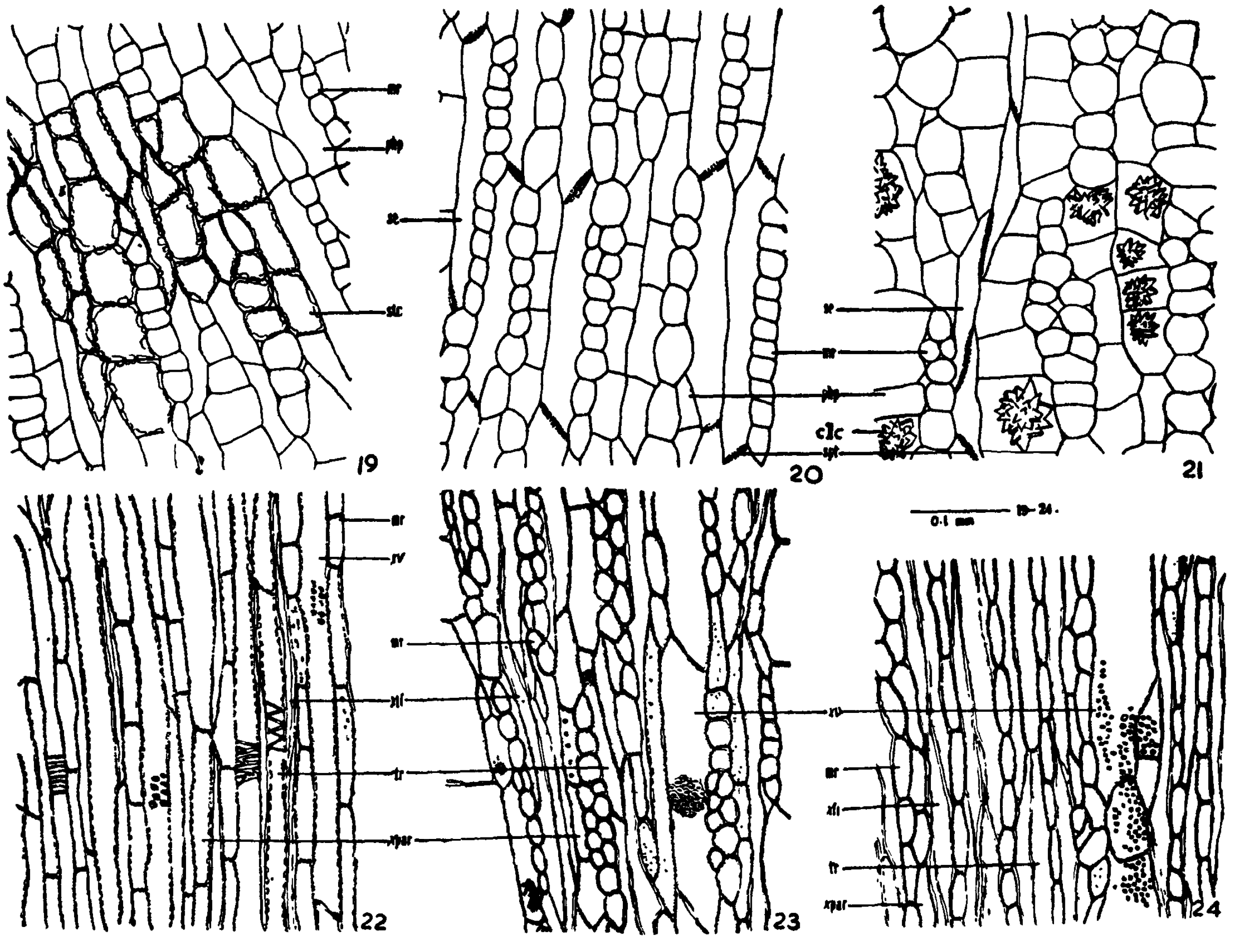
Microscopical characters of stem of *Dregea volubilis*

Figs. 15 & 16 : 15. Part of t.s. of mature stem (diagrammatic). 16. Part of t.s. of Fig. 15 showing cellular details. A. Phellem to outer phloem. B. Middle phloem. C. Inner phloem and cambium.



Microscopical characters of stem of *Dregea volubilis*

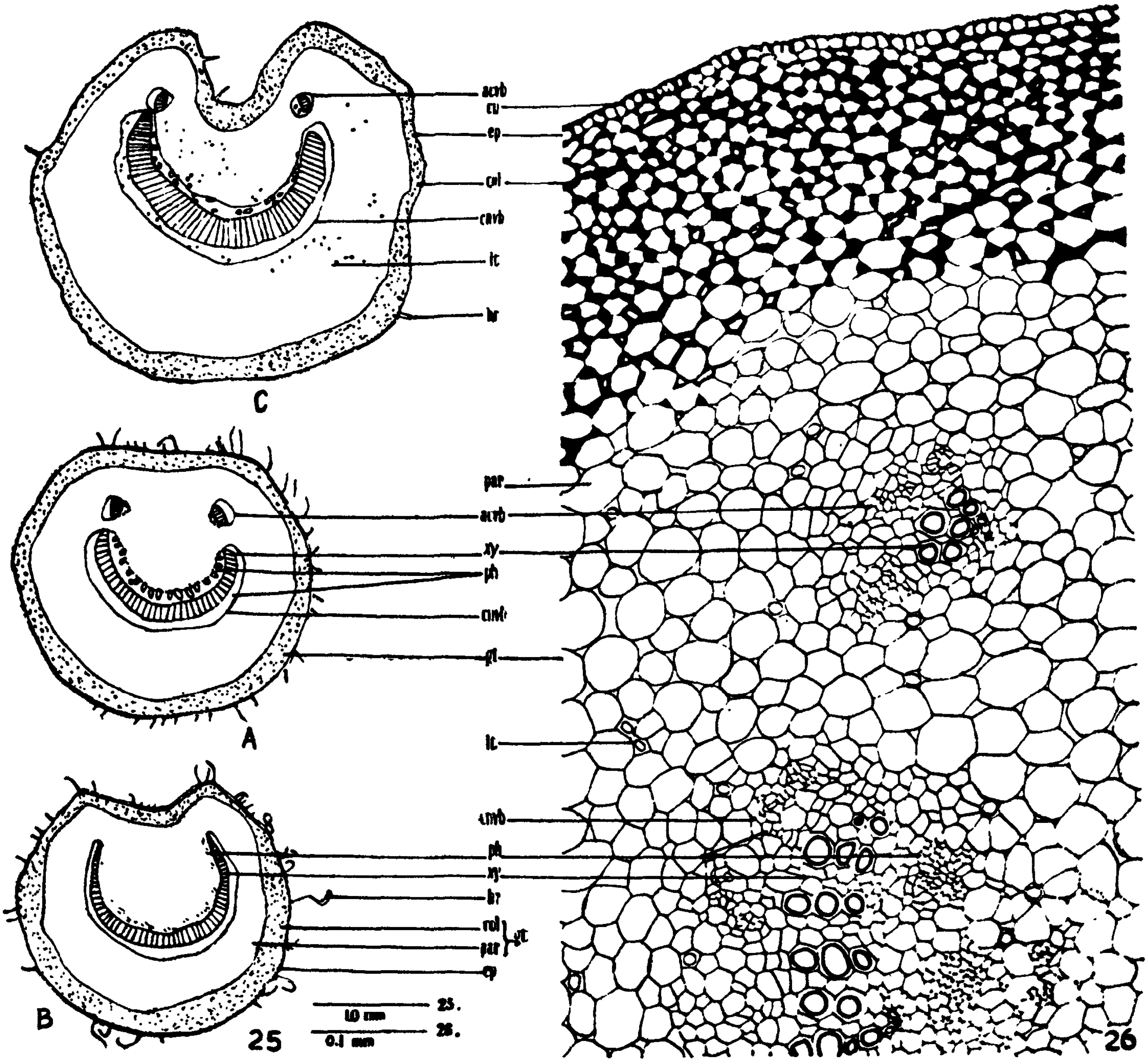
Figs. 17 & 18 : 17. Part of t.s. of Fig. 15 showing xylem and pith. 18. Isolated elements : a-j. Vessel elements. k-r. Tracheids. s_1-s_7. Xylem parenchyma. t_1-t_9. Stone cells. u-w. Libriform fibres. x. Starch grains.



Microscopical characters of stem of *Dregea volubilis*

Figs. 19-24 : 19. Tangential section through outer phloem region. 20. Tangential section through inner phloem region. 21. Tangential section through middle phloem region. 22. Tangential section through inner xylem region. 23. Tangential section through middle xylem region. 24. Tangential section through outer xylem region.

less often cordate. The surface is glabrous or softly tomentose with main lateral nerves upto 5 pairs branching into reticulate veins (Figs. 1A-F). The petiole is stout glabrescent terete obscurely channelled above and 1.5-6.5 cm long. Transections of the petiole show gradual development of a groove on its ventral side (Figs. 25 A-C) ; single layered epidermis with many non-glandular, 121-174-304-499 µm long, 12-celled (more commonly 6-8-celled), uniseriate trichomes ; a cortex composed of both collenchyma and parenchyma and 3 vascular traces (Fig. 26). The central bundle is the largest and crescent-shaped while two others are much smaller and somewhat circular flanking slightly above but close to the arms of the central one (Figs. 25 A, 26). On the other end of petiole close to the laminar base, these traces, however, get fused together (Fig. 25-B). The lamina has a dorsiventral structure (Figs. 29, 30A-C). The epidermis shows striated cuticle, mixed anomocytic and paracytic stomata and the trichomes as found elsewhere in this plant (Figs. 31, 33-35). The lacunose mesophyll has the palisades arranged like row of stakes with palisade-ratio 5.22 (range 4-10) and the spongy parenchyma 3-5 layered (Figs. 30A-C, 31). The veins are usually embedded and transcurrent. Some digitate vein endings without phloem also occur. The



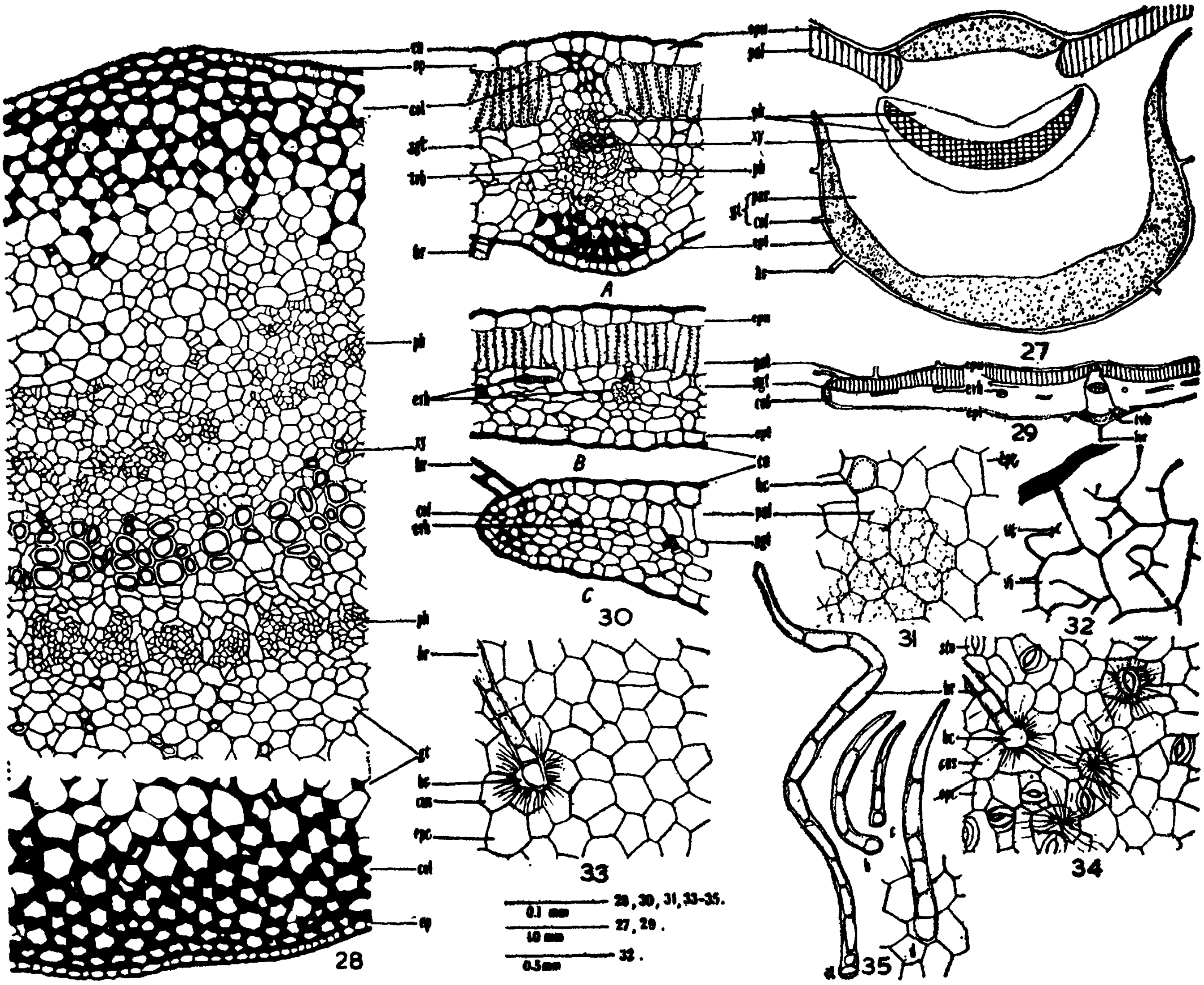
Microscopical characters of leaf of *Dregea volubilis*

Figs. 25 & 26 : 25. T.S. of petiole (diagrammatic) : A. Basal region. B. Apical region. C. Middle region. 26. Part of t.s. of Fig. 25B showing cellular details.

vein-termination and vein-islet per sq. mm are 20.4 (range 14-31) and 5.1 (range 2-10) respectively (Figs. 30A-C, 32). The laminar margins have thick-walled parenchyma in mesophyll region (Fig. 30C). The mid-rib has collenchyma following the epidermis in dorsal and ventral bulge and a single crescent-shaped bundle in the centre of its parenchymatous ground tissue (Figs. 27, 28).

Cell-contents :

The latex as yellow-brown content occurs in laticifers. The cluster crystals of calcium oxalate (21-39-65-83 μm in diameter) and the resins are found frequently in the bark of both young and mature root and stem. The prismatic crystals (measure 4-8-*16*-46 × 4-*16*-30-60 μm) also occur occasionally in the stem. The starch grains both simple and compound are present more abundantly in root than in stem. The simple grains measure 3-*12*-19 × 4-*12*-20 μm and are spherical, sub-spherical and sub-reniform in shape with a linear hilum in the centre. The compound granules measure 12-30-56 μm in



Microscopical characters of leaf of *Dregea volubilis*

Figs. 27-35 : 27. T.S. of mid-rib (diagrammatic). 28. Part of t.s. of Fig. 27 showing cellular details. 29. Part of t.s. of lamina (diagrammatic). 30. Part of t.s. of Fig. 29 showing cellular details. A. Lamina with transcurrent vein. B. Lamina with embedded veins. C. Marginal lamina. 31. Surface view of palisade cells under upper epidermis. 32. Laminar surface showing vein-islets and vein-termination. 33. Surface view of upper epidermis showing cuticular striation and trichome. 34. Surface view of lower epidermis showing stomata, cuticular striation and trichome. 35. a-d. Trichomes.

diameter and have 2-6 components. The tannins occur as light brown granular mass in some of the cells of inner cork and phelloderm of the root and stem and also in leaf. Besides, the steroids, reducing sugars, polysaccharides/glycosides, and alkaloids are detected in various extractives (Table-1).

Physico-chemical Studies :

Three samples each of powdered root, stem and leaf (20 g) were soxhlated successively with different solvents. Fluorescence characteristics of extractives under UV radiation were studied after spotting the extract on a non-fluorescent filter paper and treating with various reagents. Solvents from the respective extract were evaporated and the average yield percentage of each extractive calculated. Physical appearance and consistency were noted. These were further screened for steroids/triterpenes, alkaloids, flavonoids, reducing sugars, saponins, polysaccharides/glycosides, tannins, resins using the usual testing procedures. The results obtained are summarised in Table 1. The extractives were also subjected to unidirectional thin layer chromatography on silicagel G plates. Chromatograms of respective extractive was exposed to UV light to record the colour fluoresced by different components and their hRf values (Table 2).

The aqueous extract of the root, stem and leaf separately treated with phloroglucinol and conc. HCl showed orange colour in case of the former and no change in two latter ones. Similarly the above extracts separately treated with resorcinol and conc. HCl, on heating gave violet to deep crimson red colour in the root, deep orange in the stem and deep yellow in the leaf. The powders of the root, stem and leaf treated separately with nitrocellulose emit respectively pale-green, pinkish brown with green tinge and orange fluorescence under UV radiation. The average value for ash and acid insoluble ash with reference to dried root, stem, leaf and whole plant respectively are 4.11, 3.72, 10.86, 6.23 and 0.58, 0.64, 0.64, 0.62 percent w/w. Alcohol and water soluble extractives for root, stem, leaf and whole plant respectively are 7.51, 4.84, 20.68, 11.01 and 9.24, 8.12, 23.56, 19.98, respectively.

DISCUSSION AND CONCLUSIONS

The work aimed at elucidating all the details of diagnostic characters of the root, stem and leaf of *Dregea volubilis* will also clarify the previous work on the root (Datta and Mukerji, 1950). From foregoing observations, it is evident that certain characters as the diarch primary stele in the root, origin of the phellogen on the second cortical layer of the stem, presence of the pericycle as two rows of irregularly arranged strands of partially lignified fibres mixed with a few stone cells, normal secondary growth with no interxylary phloem in the wood, commonly occurring uni- and biseriate rays in both root and stem, a stout obscurely channelled petiole with three leaf traces and presence of clusters and prismatic crystals of calcium oxalate in different tissues along with histological quantitative values of leaf, certain phytochemical constants including TLC pattern of extractives and fluorescence test can provide useful clues for differentiating this species from its known substitutes.

ABBREVIATIONS

acvb, accessary vascular bundle ; bc, basal cell ; cam, cambium ; clc, cluster crystal ; cnvb, median vascular bundle ; col, collenchyma ; cor, cortex ; cr, calcium oxalate crystal ; cu, cuticle ; cus, cuticular striation ; end, endodermis ; ep, epidermis ; epb, epiblema ; epc, epidermal cell ; epl, lower epidermis ; epu, upper epidermis ; evb, embedded vascular bundle ; gt, ground tissue ; hr, hair ; itph, intraxylary phloem ; lt, laticifer ; mr, medullary ray ; pal, palisade ; par, parenchyma ; pcfi, pericyclic fibre ; per, pericycle ; ph, phloem ; phd, phelloderm ; phg, phellogen ; phm, phellem ; php, phloem parenchyma ; pi, pith ; prc, prismatic crystal ; scl, sclerenchyma ; se, sieve tube ; sgt, spongy ground tissue ; spt, sieve plate ; st, starch grain ; stc, stone cell ; sto, stoma ; tr, tracheid ; trc, trichome; tvb, transcurrent vascular bundle ; vi, vein-islet ; vt, vein-termination ; xfi, xylem fibre ; xp, primary xylem ; xpar, xylem parenchyma ; xv, xylem element ; xy, xylem.

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TABLE I

Percentage yield, consistency and physical appearance

				FLUORESCENCE UNDER ULTRA-VIOLET LIGHT				
Solvents	Average percentage of extractives (W/W)	Nature of residues	Colour of extractives	Extractive as such	Extractive treated with nitrocellulose in amyl acetate	Extractive treated with 1N. methanolic NaOH	Extractive treated with 1N. methanolic NaOH and mounted in nitrocellulose in amyl acetate	Extractive treated with 1N. HCl
1	2	3	4	5	6	7	8	9
								ROOT
Petroether (60-80°)	0.423	Waxy	Light brown	Spot fluorescences pale-yellow	Pale-yellow	Pale-yellow	Pale-yellow	Pale-yellow
Benzene	0.549	Waxy	Yellow	Spot fluorescences yellow	Pale-yellow	Pale-yellow	Pale-yellow	Pale-yellow
Chloroform	2.286	Dry brittle solid	Brown	Spot fluorescences pale-yellow	Pale-yellow	Pale-yellow	Pale-yellow with an outer dull pale-ring	Cream coloured
Alcohol	5.227	Tachy	Tan brown	Spot fluorescences yellow	Yellow	Pale-green with an outer creamish ring	Pale-yellow	Pale-yellow
Water	1.073	Tachy	Tan brown	Spot fluorescences sky blue with an outer pale-yellow ring	Skyblue with an outer dull pale yellow ring	Sky-blue with an dull pale-yellow ring	Sky-blue with an outer dull pale-yellow ring	Sky-blue with an outer dull pale-yellow ring
								STEM
Petroether (60-80°)	0.752	Waxy	Brownish pale-green	Spot fluorescences orange	Light orange	Light orange	Pinkish orange	Light orange
Benzene	0.396	Waxy	Greenish Brown	Spot fluorescences pink-brown	Pinkish orange	Dull orange	Pinkish orange	Dull orange
Chloroform	2.131	Dry brittle solid	Dark brown	Spot fluorescences pale-yellow	Pale-yellow with an outer pink ring	Sky-blue with an outer dull creamish ring	Sky-blue with an outer dull creamish ring	Sky-blue with an outer dull creamish ring
Alcohol	2.709	Tachy	Dark brown	Spot fluorescences yellowish brown	yellowish brown	Bright canary yellow	Light olive-green	Canary yellow with an outer light olive-green ring

of extractives and their broad chemical constituents.

	CHEMICAL CONSTITUENTS							
Extractive treated with 1N. HCl and mounted in nitro-cellulose in amyl acetate	Sterols Triter-penes	Alkaloids	Tannins	Reducing sugars	Polysac-charides Glycosides	Saponins	Flavonoids	Resins
10	11	12	13	14	15	16	17	18
Pale-yellow with sky-blue tinge	+ve	—ve	—ve	—ve	—ve	—ve	—ve	—ve
Pale-yellow	+ve	—ve	—ve	—ve	—ve	—ve	—ve	—ve
Pale-yellow	—ve	—ve	—ve	+ve	+ve	—ve	—ve	+ve
Pale-yellow	—ve	—ve	—ve	—ve	+ve	+ve	—ve	+ve
Sky-blue with an outer pale-yellow ring	—ve	—ve	—ve	—ve	+ve	+ve	—ve	—ve
Pinkish orange	+ve	—ve	—ve	—ve	—ve	—ve	—ve	—ve
Dull orange	+ve	—ve	—ve	—ve	—ve	—ve	—ve	—ve
Pale-white with an outer pink ring	—ve	—ve	—ve	+ve	—ve	—ve	—ve	+ve
Yellowish grey	—ve	—ve	—ve	+ve	+ve	+ve	—ve	+ve

Table I contd.

1	2	3	4	5	6	7	8	9
Water	9.282	Hygroscopic, brittle when dry	Buff-brown	Spot fluorescences brown with an outer light greenish brown ring	Brown with an outer light greenish brown ring	Brown with an outer light greenish brown ring	Brown with an outer light greenish brown ring	Brown with an outer light greenish brown ring
								LEAF
Petro-ether (60-80°)	2.727	Waxy	Brownish pale-green	Spot fluorescences orange	Orange	Orange	Pinkish orange	Orange
Benzene	2.856	Waxy	Greenish brown	Spot fluorescences brown	Brown with an outer pink ring	Brown with an outer purple-pink ring	Brown with an outer pink ring	Reddish brown
Chloroform	2.131	Dry brittle solid	Olive-brown	Spot yellowish brown	Buff-brown with an outer pinkish orange ring	Olive-green with an outer sky-blue ring	Brown with an outer dull pink ring	Pale-green with an outer purple ring
Alcohol	18.556	Tachy	Dark reddish brown	Spot greyish pale-green	Greyish pale-green	Canary yellow	Pale-green with an outer dull grey ring	Pale-green
Water	25.28	Dry brittle solid	Dark tan-brown	Spot pale-brown with an outer yellow ring	Buff-brown with an outer yellow ring	Buff-brown with an outer yellow ring	Buff-brown with an outer pale-yellow ring	Buff-brown with an pale-yellow ring

10	11	12	13	14	15	16	17	18
Pale-white with an outer olive-green ring	−ve	−ve	−ve	+ve	−ve	+ve	−ve	−ve
Pinkish orange	+ve	−ve	−ve	−ve	−ve	−ve	−ve	−ve
Reddish brown with an outer pink ring	+ve	−ve	−ve	−ve	−ve	−ve	−ve	−ve
Yellow with an outer pinkish ring	+ve	−ve	−ve	+ve	+ve	−ve	−ve	+ve
Light olive-grey with an outer dull pale ring	−ve	−ve	+ve	+ve	+ve	+ve	−ve	+ve
Yellow with an outer pale-white ring	−ve	−ve	+ve	−ve	+ve	+ve	−ve	−ve

TABLE II

Chromatographic pattern of *Dregea volubilis* under ultraviolet light

Extractive	Solvent system	No. of spots	hRf Values					
			ROOT					
Petro-ether (60-80°)	Petro- ether-Chloroform-Acetone 7 : 28 : 0.5	9	0.9 (Mi) White	2.7 (Mi) White	11.1 (Mi) White	19.4*(T) Dull-white	28.7*(T) Dull-white	50.0*(T) Dull-whit
			61.1 (Ma) Bluish green	85.5*(T) Dull-white	99.0 (Mi) White			
Benzene	Benzene-Chloroform-Acetone 6 : 60 : 1.5	8	2.9 (Ma) White	6.8 (Mi) White	19.6 (Mi) Dull-white	27.4 (Mi) Dull-white	41.1 (T) Dull-white	
			53.9 (T) Dull-white	66.8 (Ma) Bluish green	99.0 (Mi) White			
Chloroform	Petro-ether-Chlorofrom-Methanol 1 : 56 : 2.8	6	2.9 (Mi) White	5.9* (T) White	8.9* (Mi) White	17.8*(Mi) Dull-violet	38.6*(Mi) Dull-white	
			99.0 (Mi) White					
Alcohol	Benzene-Chloroform-Methanol-Water 8 : 40 : 10 : 2	10	1.7* (Mi) Dull-violet	6.1* (Mi) Dull-violet	18.4* (Mi) Dull-violet	26.3*(Mi) Dull-violet	33.3* (T) Dull-white	
			37.7* (T) Dull-white	42.9* (T) Dull-white	42.2 (T) Dull-white	81.5* (T) Dull-white	98.2*(Mi) Dull-white	
Water	Butanol-Methanol-Chloroform-Water 12.5 : 12.5 : 5 : 7.5	5	1.0 (Mi) Violet	26.0*(Ma) Dull-white short trailing	43.0*(Ma) Dull-white short-trailing	70.0*(Ma) Dull-white short trailing	98.0 (Mi) Dull-white	
			STEM					
Petro- ether (60-80°)	Petro- ether-Chloroform-Acetone 7 : 28 : 0.5	6	0.9 (T) Pinkish white	2.7 (T) Pink	30.6* (T) Dull-white	56.3*(T) Light pink	61.1 (Ma) Bluish green	99.0 (Ma White
Benzene	Benzene-Chloroform-Acetone 6 : 60 : 1.5	4	4.7 (Ma) Pink	44.7 (T) Light violet pink	63.8 (T) Dull-pink	97.1 (T) White		
Chloroform	Petro-ether-Chloroform-Methanol 1 : 56 : 2.8	4	2.9 (Mi) Violet	5.8 (Mi) Violet	13.7 (Mi) Violet trailing	99.0 (Mi) White		
Alcohol	Benzene-Chloroform-Methanol-Water 8 : 40 : 10 : 2.0	4	0.8 (Mi) Violet	4.3 (Mi) Violet	19.1 (Ma) Violet-blue	52.1* (T) Light violet-blue		
Water	Butanol-Methanol-Chloroform-Water 12.5 : 12.5 : 5 : 7.5	5	0.9 (Ma) Violet	19.6*(Ma) Violet long trailing	39.2*(Ma) Violet long trailing	64.7* Violet long trailing	98.0(Mi) Dull white	
			LEAF					
Petro-ether (60-80°)	Petro-ether-Chloroform-Acetone 7 : 28 : 0.5	5	1.8 (Mi) Pink	4.5 (Mi) Pink	16.6 (T) Light pink	56.4 (Mi) Light pink	99.0 (Mi) White	
Benzene	Benzene-Chloroform-Acetone 6 : 60 : 1.5	8	3.8 (Ma) Violet-pink	16.1(Ma) Pink trailing	40.9(Ma) Pink trailing	66.6(Ma) Pink	71.4(Ma) Violet	
			91.4*(Mi) Pink	95.2*(Mi) Violet	98.0*(T) White			
Chloroform	Petro- ether-Chloroform-Methanol 1 : 56 : 2.8	6	0.9 (Ma) Pink	2.9 (Mi) Pinkish violet	4.9 (Mi) Pinkish violet	12.8 (T) Pink	95.0 (T) Light pink	98.0 (Mi) Pinkish red
Alcohol	Benzene-Chloroform-Methanol-Water 8 : 40 : 10 : 2	4	1.7 (Ma) Pinkish violet	5.2 (Ma) Pinkish violet short trailing	34.7*(Ma) Pinkish white long trailing	78.2 (Ma) Dull-bluish green		
Water	Butanol-Methanol-Chloroform-Water 12.5 : 12.5 : 5 : 7.5	4	0.9 (Ma) Violet	40.7 (Mi) Dull-white	76.6 (Ma) Dull-white	98.0 (Mi) Dull-white		

T = in trace ; Mi = minor component ; Ma = major component

*Presence confirmed by spraying 1% sulphuric acid followed by heating the chromatographic plate at 110°C for half an hour.

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